

CLAIMS

1 1. A method of reading information characterized by comprising \\\
2 steps of:
3 one-dimensional arrangement;
4 extracting information concerning an elemental unit
5 length of the information length of the binary digit information
6 from the acquired signal; and
7 reading a ratio of the binary digit information to the
8 information length based on the extracted elemental unit length
9 information.

1 2. A method of reading information according to Claim 1,
2 characterized in that the elemental unit length information is
3 extracted as an elemental frequency information corresponding
4 to the elemental unit length, a band limiting processing is
5 effected on the acquired signal based on the extracted elemental
6 frequency information, and thereafter the ratio of the
7 information length of the binary digit information is read.

1 3. An information reading apparatus characterized by
2 comprising:
3 a signal acquiring unit for acquiring from a medium, a
4 signal containing binary digit information having a
5 predetermined information length and an arrangement;
6 an elemental frequency extracting unit for extracting an
7 elemental frequency corresponding to an elemental unit length
8 of the binary digit information of the information length from

9 the acquired signal;

10 a band limiting unit for limiting a frequency band of the

11 acquired signal based on the extracted elemental frequency

12 information;

13 a timing point extracting unit for extracting a timing

14 point which is in synchronism with the acquired signal and has

15 the elemental frequency, based on the acquired signal and the

16 elemental frequency information;

17 an amplitude extracting unit for extracting an amplitude

18 value of a signal from the band limiting unit in accordance with

19 the timing point extracted by the timing point extracting unit;

20 a tri-state value generating unit for generating tri-state

21 value data from the amplitude values extracted by the amplitude

22 extracting unit in accordance with the timing point; and

23 a reading unit for reading a ratio of the binary digit

24 information to the information length by calculating the

25 tri-state value data generated by the tri-state value generating

26 unit.

1 4. An information reading apparatus according to Claim 3,

2 characterized in that the signal acquiring unit comprises a

3 photoelectric converting unit for receiving a ray of incident

4 light and converting the received ray of light into an electric

5 signal based on the photoelectric conversion, a determining unit

6 for determining whether the electric signal supplied from the

7 photo-electric converting unit derives from photo-electric

8 conversion effected on the ray of light reflected on the medium

9 or not, and a gate unit arranged to respond to the result of
10 determination of the determining unit in such a manner that if
11 it is determined that the signal component derives from
12 photoelectric conversion effected on the reflected ray of light
13 then the signal component is acquired as the acquired signal
14 while if it is determined that the signal component derives from
15 photoelectric conversion effected on any ray of light other than
16 the reflected ray of light then the signal component is excluded
17 from an object of a signal to be acquired.

1 5. An information reading apparatus according to Claim 4,
2 characterized by an arrangement such that the determining unit
3 is supplied with a signal deriving from conversion from an analog
4 signal status to a digital signal status effected on the electric
5 signal from the photoelectric converting unit, and the
6 determining unit determines whether the signal derives from
7 photoelectric conversion effected on the ray of light reflected
8 on the medium or not.

1 6. An information reading apparatus for reading information →
2 from a medium having a mark representing a data group composed
3 of a predetermined number of pairs of information elements, each
4 of the information elements being composed of a white region
5 and a black region disposed alternately with a certain width
6 arranged to have an association with coded data, the information
7 reading apparatus acquiring the data group information as an
8 integer number ratio between the data widths of each information

9 element pair, the information reading apparatus comprising:
10 a signal acquiring unit for detecting an analog signal
11 having a variation corresponding to an intensity variation of
12 a reflected ray of light which is caused by scanning the mark
13 on the medium with a ray of light running at a predetermined
14 velocity in the scanning direction, and effecting a sampling
15 operation on the continuous signal at a predetermined sampling
16 frequency to acquire the data group information represented by
17 the mark recorded on the medium in a form of digital signal;
18 an elemental frequency extracting unit for extracting an
19 elemental frequency corresponding to an elemental unit length
20 of the width of the white region and the black region from the
21 acquired signal in the form of digital signal;
22 a band limiting unit for limiting a frequency band of the
23 acquired signal based on the extracted elemental frequency
24 information;
25 a timing point extracting unit for extracting a timing
26 point which is in synchronism with the acquired signal and has
27 the elemental frequency, based on the acquired signal and the
28 elemental frequency information;
29 an amplitude extracting unit for extracting an amplitude
30 value of a signal from the band limiting unit in accordance with
31 the timing point extracted by the timing point extracting unit;
32 a tri-state value generating unit for generating tri-state
33 value data from the amplitude values extracted by the amplitude
34 extracting unit in accordance with the timing point; and
35 a reading unit for reading a ratio of the binary digit

36 information to the information length by calculating the
37 tri-state value data generated by the tri-state value generating
38 unit, wherein

39 relationship among a width, bar[μm] of the white region
40 or the black region representing the elemental unit length of
41 the binary digit information, the scanning velocity, vmax[m/s]
42 of the scanning ray of light, and the sampling frequency, fs[MHz]
43 can be expressed by the following equation

44
$$2 < \text{fs}/(2*\text{bar}/\text{vmax}) \leq 1$$

1 7. A method of acquiring a signal for use with an information reading apparatus having a signal acquiring unit for acquiring a signal containing binary digit information recorded on a medium so as to have a predetermined information length, the information reading apparatus being arranged to extract information regarding an elemental unit length of the information length of the binary digit information from the acquired signal, thereby to read a ratio of the binary digit information to the information length based on the extracted elemental unit length information, the method of acquiring a signal for use with the information reading apparatus characterized in that

12 the signal acquiring unit acquires a signal containing the signal component and also a component other than one deriving from the medium having the binary digit information recorded thereon, determination is made on the acquired signal so as to identify a signal portion deriving from the medium having the binary digit information recorded thereon by using an amplitude

18 averaging calculation processing, and
19 the signal component deriving from the medium is cut out
20 in accordance with the result of determination, and the cut-out
21 portion is acquired as a signal containing the binary digit
22 information.

1 8. A method of effecting a band limiting processing for use 5
2 with an information reading apparatus having a signal acquiring
3 unit for acquiring a signal containing binary digit information
4 recorded on a medium so as to have a predetermined information
5 length, the information reading apparatus being arranged to
6 extract information regarding an elemental unit length of the
7 information length of the binary digit information from the
8 acquired signal, thereby to read a ratio of the binary digit
9 information to the information length based on the extracted
10 elemental unit length information, the method of effecting a
11 band limiting processing for use with the information reading
12 apparatus characterized in that
13 as a preprocessing for reading the ratio data of the binary
14 digit information to the information length, an elemental
15 frequency corresponding to the elemental unit length is extracted
16 from the acquired signal, and the frequency band of the acquired
17 signal is limited based on the extracted elemental frequency.

1 9. A method of extracting a timing point amplitude for use with 6
2 an information reading apparatus having a signal acquiring unit
3 for acquiring a signal containing binary digit information

4 recorded on a medium so as to have a predetermined information
5 length, an elementary frequency extracting unit for extracting
6 an elementary frequency corresponding to an elementary unit
7 length of the information length of the binary digit information
8 obtained from the acquired signal, and a band limiting unit for
9 limiting a frequency band of the acquired signal based on the
10 extracted elemental frequency information, wherein a ratio of
11 the binary digit information to the information length is read
12 from the signal having undergone the frequency band limitation
13 in the band limiting unit, the method of extracting the timing
14 point amplitude for use with the information reading apparatus
15 characterized in that

16 as a preprocessing for reading the ratio data of the binary
17 digit information to the information length, a timing point in
18 synchronism with the acquired signal and having the elemental
19 frequency is extracted based on the acquired signal and the
20 elemental frequency information, an amplitude value of a signal
21 from the band limiting unit is extracted in accordance with the
22 extracted timing point, and tri-state value data is generated
23 from the extracted amplitude values in accordance with the timing
24 point.

1 10. A method of reading information from a medium having a mark
2 recorded thereon, the mark representing a data group composed
3 of a predetermined number of information element pairs each
4 composed of a white region and a black region each having a width
5 length and disposed alternately on the mark for representing

6 the data group, the method of reading information achieving
7 information reading by acquiring the data group information as
8 an integer number ratio between the width length data of each
9 information element pair, characterized by comprising steps of:
10 scanning a ray of light on the mark at a predetermined
11 velocity to cause a reflected ray of light, detecting a signal
12 having a variation corresponding to an intensity variation of
13 the reflected ray of light deriving from the scanning in the
14 scanning direction, thereby acquiring a signal containing binary
15 digit information corresponding to the intensity variation of
16 the reflected ray of light;
17 extracting an elemental frequency corresponding to an
18 elemental width time of the width data from the acquired signal;
19 effecting band limitation on the acquired signal to obtain
20 an optimum signal band based on the extracted elemental
21 frequency; and
22 reading integer number ratio between the data widths of
23 each information element pair from the acquired signal having
24 undergone the band limitation based on the elemental frequency.

1 11. A method of reading information according to Claim 10,
2 characterized in that each processing from a step of acquiring
3 the detected signal having the intensity variation in the
4 reflected ray of light to a step of reading the integer number
5 ratio between the width length data of each information element
6 pair contains a differential processing characteristic of a time
7 span substantially corresponding to the elemental width time

8 or a time span substantially corresponding to one slightly
9 smaller than the elemental width time.

1 12. A method of reading information according to Claim 10,
2 characterized in that each processing from a step of acquiring
3 the detected signal having the intensity variation in the
4 reflected ray of light to a step of reading the integer number
5 ratio between the width length data of each information element
6 pair contains a differentiating processing characteristic of
7 a gain peak frequency substantially corresponding to the
8 elemental frequency equivalent to the elemental width time or
9 a frequency substantially corresponding to one slightly larger
10 than the elemental frequency.

1 13. A method of reading information according to Claim 12,
2 characterized in that the differentiating processing
3 characteristic is arranged to have a gain characteristic of a
4 cosine equivalent characteristic having a gain peak frequency
5 substantially corresponding to the elemental width time of the
6 width information of the input signal or a gain peak frequency
7 substantially corresponding to one slightly larger than the gain
8 peak frequency whereas the differentiating processing
9 characteristic is arranged to have a phase characteristic tending
10 to vary linearly with respect to the frequency.

1 14. A method of reading information according to Claim 10,
2 characterized in that the step of extracting the elemental

3 frequency is further arranged to comprise steps of:
4 effecting a differentiating processing on the acquiring
5 signal in such a manner that the gain peak frequency is set to
6 a value equal to or larger than the maximum frequency of the
7 acquired signal in a signal acquisition allowable region;
8 effecting a squaring processing on a signal having
9 undergone the differentiating processing;
10 analyzing the result deriving from the squaring processing
11 based on frequency spectrums; and
12 determining that a significant certain frequency except
13 for 0Hz is regarded as the elemental frequency based on the result
14 of analysis using the frequency spectrums.

1 15. A method of reading information according to Claim 10,
2 characterized in that the step of extracting the elemental
3 frequency is further arranged to comprise steps of:
4 effecting a differentiating processing on the acquiring
5 signal in such a manner that the gain peak frequency is set to
6 a value equal to or larger than the maximum frequency of the
7 acquired signal in a signal acquisition allowable region;
8 effecting a squaring processing on a signal having
9 undergone the differentiating processing;
10 analyzing the result deriving from the squaring processing
11 based on frequency spectrums;
12 determining that a significant certain frequency except
13 for 0Hz is regarded as the elemental frequency based on the result
14 of analysis using the frequency spectrums;

15 effecting demodulating processing on the signal having
16 undergone the squaring processing based on the frequency obtained
17 by the frequency calculation and forming the signal into a vector;
18 removing a high frequency component from the signal having
19 undergone the demodulation and the vector formation;
20 obtaining a phase difference between a signal from which
21 the high frequency component is removed and a signal delayed
22 by one sample time from that signal;
23 calculating a deviation of the elemental frequency in terms
24 of frequency relative to the obtained elemental frequency based
25 on the above-obtained phase difference; and
26 determining that the result obtained by adding the
27 calculated frequency deviation to the obtained elemental
28 frequency is the elemental frequency information.

1 16. A method of reading information according to Claim 10,
2 characterized in that when the signal containing the binary digit
3 information is acquired, the manner of signal acquisition is
4 such that the signal is acquired as a digital signal having
5 undergone sampling operation at a predetermined sampling
6 interval, and as a preprocessing for reading the integer number
7 ratio between the width length data of each information element
8 pair, data number decimation is effected on the digital signal
9 having undergone the signal band limitation in accordance with
10 the elemental frequency information.

1 17. A method of reading information from a medium having a mark

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2 recorded thereon, the mark representing a data group composed
3 of a predetermined number of information element pairs each
4 composed of a white region and a black region each having a width
5 length and disposed alternately on the mark for representing
6 the data group, the method of reading information achieving
7 information reading by acquiring the data group information as
8 an integer number ratio between the width length data of each
9 information element pair, the method characterized by comprising
10 steps of:

11 scanning a ray of light on the mark at a predetermined
12 velocity to cause a reflected ray of light, detecting a signal
13 having a variation corresponding to an intensity variation of
14 the reflected ray of light deriving from the scanning in the
15 scanning direction, thereby acquiring a signal containing binary
16 digit information corresponding to the intensity variation of
17 the reflected ray of light;

18 extracting a timing point containing the width data from
19 the acquired signal; and

20 reading the integer number ratio between the data widths
21 of each information element pair from the mark in accordance
22 with the extracted timing point.

1 18. A method of reading information according to Claim 17,
2 characterized in that when the timing point is extracted,
3 differentiating processing is effected on the acquired signal,
4 a timing point is specified in the signal having undergone the
5 differentiating processing in order that the information length

6 of the binary digit information recorded on the medium can be
7 read, and tri-state value digital information is extracted from
8 the amplitude of the signal having undergone the differentiating
9 processing at every specified timing point.

1 19. A method of reading information according to Claim 17,
2 characterized in that when the timing point is extracted,
3 differentiation processing is effected on the acquired signal,
4 a frequency component corresponding to the elemental width time
5 of the width length data is extracted while the signal having
6 undergone the differentiation processing is handled as an input
7 signal, a periodic signal is generated so as to correspond to
8 the elemental width time while the signal having undergone the
9 differentiating processing is handled as an input signal, and
10 a timing point corresponding to the existing point of the mark
11 width information is specified while the generated periodic
12 signal is handled as an input signal, whereas

13 when the integer number ratio between the width length
14 data of each information element pair is read, an amplitude value
15 is taken out from the signal having undergone the differentiation
16 processing at every specified timing point, and the amplitude
17 value of the signal taken out at every specified timing point
18 is converted into tri-state value digital data.

1 20. A method of reading information from a medium having a mark
2 recorded thereon, the mark representing a data group composed
3 of a predetermined number of information element pairs each

4 composed of a white region and a black region each having a width
5 length and disposed alternately on the mark for representing
6 the data group, the method of reading information achieving
7 information reading by acquiring the data group information as
8 an integer number ratio between the width length data of each
9 information element pair, the method characterized by comprising
10 steps of:

11 scanning the mark with a ray of light running at a
12 predetermined velocity;

13 receiving a ray of light coming from the outside and
14 outputting an intensity variation detecting signal representing
15 the intensity variation of the received ray of light; and
16 determining whether or not the received ray of light is
17 one having scanned the mark and reflected therefrom based on
18 the intensity variation detecting signal; wherein

19 in accordance with the result of determination, a signal
20 reflected on the mark coming from an intensity variation
21 detecting width information medium is acquired as a signal for
22 reading information of the data group as an integer number ratio
23 between the width length data of each information element pair,
24 while any component of the intensity variation state detecting
25 signal other than the component of the ray of light reflected
26 on the mark is excluded from an object of the signal to be acquired.

1 21. A method of reading information according to Claim 20,
2 characterized in that when examination is made to determine
3 whether the received ray of light is one having scanned the mark

4 and reflected therefrom or not, the intensity variation optical
5 signal is subjected to a differentiation processing, the
6 differentiated signal having undergone the differentiating
7 processing is squared, and moving average is calculated on the
8 squared differentiated signal, and

9 an intensity variation state detecting signal part is cut
10 out from the ray of light reflected on the mark based on a value
11 obtained by the method of moving average, whereby the cut-out
12 signal part is acquired as a acquired signal.

1 22. A method of reading information according to Claim 20,
2 characterized by a procedure to be done when examination is made
3 to determine whether the received ray of light is one having
4 scanned the mark and reflected therefrom or not, the procedure
5 comprising steps of:

6 subjecting the intensity variation optical signal to a
7 differentiation processing;

8 squaring the differentiated signal;

9 calculating moving average on the squared differentiated
10 signal;

11 examining whether the extracted maximum value of the moving
12 averages exceeds a first threshold value or not to determine
13 a status of validity for the squared differentiated signal in
14 such a manner that, if it is determined that the maximum value
15 exceeds the first threshold value the differentiated squared
16 signal is regarded as a valid signal while if is determined that
17 the maximum value does not exceed the first threshold value the

18 differentiated squared signal is regarded as an invalid signal;
19 effecting an averaging processing on the differentiated
20 squared signal in a period in which the differentiated squared
21 signal is valid, thereby obtaining an averaged value thereof;
22 extracting the maximum value from the differentiated
23 squared signal in a period in which the differentiated squared
24 signal is valid;
25 calculating the difference between the averaged value and
26 the maximum value of the differentiated squared signal in a period
27 in which the differentiated squared signal is valid;
28 comparing the difference with a predetermined second
29 threshold value to determine a way of acquiring the intensity
30 variation state detecting signal in such a manner that, if the
31 difference is smaller than the second threshold value a portion
32 of the intensity variation state detecting signal corresponding
33 to the aforesaid period is cut out so that only the cut-out signal
34 portion is acquired as an acquired signal while if the difference
35 is larger than the second threshold value the portion of the
36 intensity variation state detecting signal corresponding to the
37 aforesaid period is excluded as an object to be acquired as the
38 acquired signal.

1 23. A method of reading information characterized by comprising \ ,
2 a step of acquiring a value from a signal containing binary digit
3 information having a predetermined information length and
4 deriving from information elements arrayed one-dimensionally
5 on a medium at every equal time interval, wherein

6 when an elemental unit length of the information length
7 of the binary digit information is extracted from the acquired
8 signal, the portion of the signal for extracting the state of
9 the binary digit information from the medium information has
10 a band narrower than that of the characteristic for
11 differentiation based on the equal time interval.

1 24. A method of reading information according to Claim 23,
2 characterized in that the elemental unit length information is
3 extracted as elemental frequency information corresponding to
4 the elemental unit length, the read signal is subjected to
5 band-limitation processing based on the extracted elemental
6 frequency information, and after differentiating processing is
7 effected thereon, a ratio of binary digit information to the
8 information length is read.

1 25. A read signal processing unit comprising:
2 means for acquiring a signal containing binary digit
3 information having a predetermined information length and
4 deriving from information elements arrayed one-dimensionally
5 on a medium and extracting an elemental frequency corresponding
6 to the elemental unit length of the information length of the
7 binary digit information from the acquired signal; and
8 means for effecting a band limiting processing on the
9 acquired signal based on the extracted elemental frequency signal
10 and thereafter extracting boundary information of the binary
11 digit information.

1 26. A read signal processing unit comprising:
2 means for acquiring a signal containing binary digit
3 information having a predetermined information length and
4 deriving from information elements arrayed one-dimensionally
5 on a medium and extracting an elemental frequency corresponding
6 to the elemental unit length of the information length of the
7 binary digit information from the acquired signal; and
8 means for effecting a band limiting processing on the
9 acquired signal based on the extracted elemental frequency signal
10 and thereafter extracting a ratio of the information length of
11 the binary digit information.

1 27. A method of processing a read signal comprising steps of
2 acquiring a signal containing binary digit information having
3 a predetermined information length and deriving from information
4 elements arrayed one-dimensionally on a medium, extracting an
5 elemental frequency information corresponding to the elemental
6 unit length of the information length of the binary digit
7 information from the acquired signal, effecting a band limiting
8 processing on the acquired signal based on the extracted
9 elemental frequency signal, and thereafter extracting a ratio
10 of the information length of the binary digit information, the
11 method of processing a read signal carrying out further procedure
12 upon extracting the elemental frequency, the further procedure
13 comprising steps of:
14 effecting a differentiation processing on the signal

15 acquired from the medium in such a manner that the gain peak
16 frequency is set to a value equal to or larger than the maximum
17 frequency of the acquired signal in a signal acquisition
18 allowable region;

19 effecting a squaring processing on a signal having
20 undergone the differentiating processing;

21 analyzing the result deriving from the squaring processing
22 based on frequency spectrums;

23 calculating a characteristic data having a property
24 inverse to an approximated characteristic data on the result
25 of the frequency spectrum analysis;

26 correcting the result of the frequency spectrum analysis
27 by using the inverse characteristic data obtained by the
28 calculation; and

29 extracting a significant certain frequency except for 0Hz
30 as the elemental frequency based on the result of analysis using
31 the frequency spectrums.

1 28. A method of processing a read signal for use with an ✓
2 information reading apparatus comprising a signal acquiring unit
3 for acquiring a signal containing binary digit information having
4 a predetermined information length and deriving from information
5 elements arrayed one-dimensionally on a medium, and a read signal
6 processing unit for extracting an elemental frequency
7 information corresponding to the elemental unit length of the
8 information length of the binary digit information from the
9 acquired signal, effecting a band limiting processing on the

10 acquired signal based on the extracted elemental frequency signal,
11 and thereafter reading a ratio of the information length of the
12 binary digit information, the method of processing a read signal
13 for use with the information reading apparatus carrying out
14 further procedure upon extracting the elemental frequency by
15 the read signal processing unit, the further procedure comprising
16 steps of:

17 effecting a differentiation processing on the signal
18 acquired by the signal acquiring unit in such a manner that the
19 gain peak frequency is set to a value equal to or larger than
20 the maximum frequency of the acquired signal in a signal
21 acquisition allowable region;

22 effecting a squaring processing on a signal having
23 undergone the differentiation processing;

24 analyzing the result deriving from the squaring processing
25 based on frequency spectrums;

26 calculating a characteristic data having a property
27 inverse to an approximated characteristic data on the result
28 of the frequency spectrum analysis;

29 correcting the result of the frequency spectrum analysis
30 by using the inverse characteristic data obtained by the
31 calculation; and

32 extracting a significant certain frequency except for 0Hz
33 as the elemental frequency based on the result of the frequency
34 spectrums analysis corrected.

1 29. A read signal processing apparatus comprising an elemental

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2 frequency extracting unit for acquiring a signal containing
3 binary digit information having a predetermined information
4 length and deriving from information elements arrayed
5 one-dimensionally on a medium and extracting elemental frequency
6 information corresponding to the elemental unit length of the
7 information length of the binary digit information from the
8 acquired signal, and an information length ratio extracting unit
9 for effecting a band limiting processing on the acquired signal
10 based on the elemental frequency signal extracted by the
11 elemental frequency extracting unit and thereafter extracting
12 a ratio of the information length of the binary digit information,
13 the elemental frequency extracting unit comprising:
14 a differentiation processing unit for effecting a
15 differentiation processing on the signal acquired from the medium
16 in such a manner that the gain peak frequency is set to a value
17 equal to or larger than the maximum frequency of the acquired
18 signal in a signal acquisition allowable region;
19 a squaring processing unit for effecting a squaring
20 processing on a signal having undergone the differentiation
21 processing in the differentiation processing unit;
22 a frequency spectrum analyzing unit for analyzing the
23 result deriving from the squaring processing effected by the
24 squaring processing unit based on frequency spectrums;
25 an inverse characteristic data calculating unit for
26 calculating a characteristic data having a property inverse to
27 an approximated characteristic data which results from the
28 frequency spectrum analysis supplied from the frequency spectrum

29 analyzing unit;
30 an analyzed result correcting unit for correcting the
31 result of the frequency spectrum analysis by using the inverse
32 characteristic data obtained by the calculation by the inverse
33 characteristic data calculating unit; and
34 an extracting unit for extracting a significant certain
35 frequency except for 0Hz as the elemental frequency based on
36 the result of the frequency spectrum analysis corrected by the
37 analyzed result correcting unit.

1 30. An information reading apparatus composed of a signal \b
2 acquiring unit for acquiring a signal containing binary digit
3 information having a predetermined information length and
4 deriving from information elements arrayed one-dimensionally
5 on a medium and a reading processing unit comprising an elemental
6 frequency extracting unit for extracting elemental frequency
7 information corresponding to the elemental unit length of the
8 information length of the binary digit information from the
9 acquired signal supplied from the signal acquiring unit and an
10 information length ratio extracting unit for effecting a band
11 limiting processing on the acquired signal based on the elemental
12 frequency signal extracted by the elemental frequency extracting
13 unit and thereafter extracting a ratio of the information length
14 of the binary digit information,
15 the elemental frequency extracting unit comprising:
16 a differentiation processing unit for effecting a
17 differentiating processing on the signal acquired from the medium

18 in such a manner that the gain peak frequency is set to a value
19 equal to or larger than the maximum frequency of the acquired
20 signal in a signal acquisition allowable region;

21 a squaring processing unit for effecting a squaring
22 processing on a signal having undergone the differentiation
23 processing in the differentiation processing unit;

24 a frequency spectrum analyzing unit for analyzing the
25 result deriving from the squaring processing effected by the
26 squaring processing unit based on frequency spectrums;

27 an inverse characteristic data calculating unit for
28 calculating a characteristic data having a property inverse to
29 an approximated characteristic data on the result of the
30 frequency spectrum analysis supplied from the frequency spectrum
31 analyzing unit;

32 an analyzed result correcting unit for correcting the
33 result of the frequency spectrum analysis by using the inverse
34 characteristic data obtained by the calculation by the inverse
35 characteristic data calculating unit; and

36 an extracting unit for extracting a significant certain
37 frequency except for 0Hz as the elemental frequency based on
38 the result of the frequency spectrums analysis corrected by the
39 analyzed result correcting unit.